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A SYSTEM APPROACH FOR SOLVING EDUCATIONAL PROBLEMS.

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THIS PAPER INVESTIGATES VARIOUS ASPECTS OF THE SYSTEMS APPROACH FOR SOLVING EDUCATIONAL PROBLEMS--(1) THE SYSTEMS CONCEPT, (2) THE RELIABILITY OF THE ASSUMPTIONS ON WHICH THE SYSTEMS APPROACH IS BASED, (3) THE LIMITATIONS INHERENT IN THE SYSTEMS APPROACH, (4) THE HUMAN ELEMENT AND ITS RELATIONSHIP WITH THE SYSTEMS APPROACH, (5) THE WAYS THE SYSTEMS APPROACH HAS BEEN USED TO EFFECTIVELY SOLVE PROBLEMS, (6) WHAT IS MEANT BY A SYSTEM, SYSTEM ANALYSIS, SYSTEM SYNTHESIS, AND SYSTEM APPROACH, AND (7) THE BENEFITS THE SYSTEMS APPROACH OFFERS TO EDUCATION. ALSO INCLUDED IS A MODEL OF A SYSTEM APPROACH AS A LOGICAL TOOL FOR PROBLEM SOLVING AND A RATIONALE AND FRAMEWORK FOR IMPLEMENTING A SYSTEMS APPROACH TO PROBLEM SOLVING WITHIN THE EDUCATIONAL SYSTEM. (HW)

Orientation

November 1967

Prepared by:

The Staff of OPERATION PEP

OPERATION PEP

Lesson No. 1

A SYSTEM APPROACH FOR SOLVING EDUCATIONAL PROBLEMS

- An introduction to a system approach
- An explanation of what this approach entails
- An overview of the benefits it offers

by

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OPERATION PEP: A State-wide Project to
Prepare Educational Planners for California

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As a potential user of the system approach, you need to know the answers to the following questions:

1. How new is the "system" concept?

2. How reliable are the assumptions on which the system approach is based?

3. What, if any, limitations are inherent in the system approach?

4. Will use of the system approach dehumanize the educational system?

5. In what ways has the system approach been used effectively to solve problems?

How New Is The "System" Concept?

1 The system concept is not new, but like every other concept man's present understanding, interpretation and application of the concept reveals an evolution in its meaningful utilization. The concept has been expanded, during the course of its evolution, and has been validated through historical use and subsequent appraisals.

2 The system concept can be traced back to ancient civilizations who viewed the universe as a system of interacting phenomena. It was man's curiosity and his desire to understand and predict the behavior of theoretical and natural systems that prompted his quest for knowledge. As the dimensions of the universe and knowledge were widened, the system concept expanded and became dynamic. The system concept, subsequently, can be regarded as a functionally relevant logic construct for use in studying any given context.

3 Historically, then, the concept can be traced through the developing discourse of logic, philosophy, science, mathematics and religion to its modern usage and interpretation. The concept has proved to be a valuable construct in logic and philosophy. The methods of science depended upon the orderly nature and the discipline that the concept enabled man to achieve as he sought to develop a more logical understanding of the theoretical and natural systems confronting him.

4 One definition of the term, "system" has been stated as:

> "A system is the structure or organization of an orderly whole, clearly showing the interrelationship of the parts to each other and to the whole itself."[1]

5 The stated definition represents a structural and functional approach to an understanding of the system concept. Whether or not this definition adequately provides for all aspects of system dynamics is open to speculation. However, since the meaning of any concept is transitory in nature, its insightful benefit will depend upon the relative states of art and usage at a point in time. (Certainly, the author of the definition benefited through its use at some point of application and/or time.)

6 When the system concept was applied to any number of given contexts, its meaning expanded to include performance contexts, including those of human behavior. In such cases, the critical determinants of system performance effectiveness were the performance requirements (what was required of the system) and the products of performance. Performance effectiveness was determined by evaluating the system products and/or benefits (resulting from performance) using system requirements as criteria. The structure and function of the system could, in turn, be appraised using product effectiveness criteria. Since product effectiveness could be directly related to the cost of functionally-related performance in any defined system, cost-effectiveness criteria came to be utilized in evaluation

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[1]Henry A. Bern and others, "Reply to Questions About Systems," Audiovisual Instruction, X(5), p. 367.

(costs are defined as expenditures of effort).

7 An operational definition of the term, "system" has been prepared by the OPERATION PEP staff as:

> "A system is the sum total of separate parts working independently and in interaction to achieve previously specified objectives."[2]

8 This definition is consistent with the expanded meaning of the system concept as it applies to performance contexts. However, the idea of gestalt is not incorporated in this definition and its absence indicates a possible weakness in terms of the system concept.

9 Another operational definition of the term "system" has been presented as:

> "A system is the gestalt which results from the sum total of the separate parts working independently and in interaction to achieve previously specified objectives."[3]

The stated definition incorporates the idea of gestalt and, thereby, the idea that the effect created by the sum total of the separate parts working independently and in interaction is greater than one could predict based upon an examination of the individual parts.

10 Realizing, however, that knowledge is only tentative and human understanding varies, the definitions presented and their meanings must be regarded as transitory in nature. Regardless of the definition used, everyone is aware of many examples of contexts which have, or can be, regarded as a system. Certainly,

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[2]Primarily Roger A. Kaufman and Robert E. Corrigan.

[3]Revision by Donald R. Miller and Helen Smeltzer.

- The universe is a system.
- Our environment can be considered as a system.
- Our bodies can be regarded as systems.
- A problem context can be studied as a system.

How Reliable Are The Assumptions On Which The System Approach is Based?

11 Since the system approach is based upon and utilizes the methods of science and logic, its basic assumptions can be assessed using the same reliability criteria as are used in these disciplines. System theory and technology has produced a field of inquiry specific to it which provides discrete methods, procedures, skills and knowledges. Each of these provisions must be utilized before reliability can be established.

12 Regarding the use of the methods of science in establishing a system approach, Quade has stated that:

> "This means in essence that it strives for the same traditions. Scientific tradition holds that: (1) results are obtained by processes that another scientist can duplicate to attain the same results; (2) all calculations, assumptions, data and judgements are made explicit and thus subject to checking, criticism, and disagreement; (3) the scientific method is objective; its propositions do not depend on personalities, reputations, or vested interests; where possible it is quantitative and experimental. For operations research and system analysis, however, these are still unachieved goals."[4]

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[4]E. S. Quade (Ed.), Analysis for Military Decisions, Rand Report R-387-PR (Santa Monica, Calif.: The Rand Corp., 1964), p. 150.

13 The methods of science depend upon human judgments in application. It must be realized that errors in human judgment may produce failure but that such failure does not affect the reliability of basic assumptions. The system approach is:

- More method than magic.
- More explicit than implicit.
- More objective than subjective.

Its application can produce results which are:

- Honest in terms of the problem context.
- Practical in terms of solution to the problem.
- Objective in terms of how the problem is solved.

What, If Any, Limitations Are Inherent In The System Approach?

14 The system approach is an evolving science and technology and, as such, is subject to limitations and possible pitfalls. One of its obvious limitations resides in the developmental states of its knowledge base and its art. Another limitation of the approach stems from the levels of understanding and expertise possessed by those who attempt to use it.

15 Other insights concerning limitations of the system approach are evident in the following quotations:

> "System analysis...is still largely a form of art...we have to do some things that we think are right but that are not verifiable, that we cannot really justify, and that are never checked in the output of work. Also we must accept as inputs many relative intangible factors derived from human judgement, and we must present answers

to be used as a basis for other judgments. Whenever possible, this judgment is supplemented by inductive and numerical reasoning, but it is only judgment nonetheless."[5]

"...systems analysis and operations research are successful aids to policy determination in areas...where there is no accepted theoretical foundation precisely because they are designed to make systemic and efficient rather than haphazard and unguided use of judgment by specialists or experts in the fields of interest. The essence of their method is to construct a 'model' appropriate to the problem; such a model...introduces a precise structure and terminology that serves primarily as an effective means of communication, and, through feed-back...helps the expert to arrive at a clearer understanding of the subject matter and the problem."[6]

16 Thus, users of the system approach must realize that it is:

- A means to an end.
- A methodological approach to decision-making.
- A logical tool for problem-solving.
- Subject to certain limitations.
- No better than the understanding of the person that applies it.

Will Use of the System Approach Dehumanize the Educational System?

17 One must realize that the system approach is a powerful technology that can be used to enhance human resources. Thus, the system approach to problem solving enhances human capabilities to make decisions and solve problems. Frequently, people who are unfamiliar with the system approach express concern that the new technology will dehumanize the educational process. Consider

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5 [5]E. S. Quade, Ibid., p. 153.

6 [6]Ibid., p. 153.

the following rationale expressed by Stover:

> "To some, the prospect of employing system approaches to human problems seems reprehensible because they think it means that people will be 'engineered.' Briefly, they argue that system techniques are largely the province of engineers and have had their fullest development in handling physical tasks involving hardware, not people; that system engineers as a group have too little appreciation for social and human factors; and that the idea of system management implies the control of individual action, which is undesirable in democratic communities. Certainly each of these points holds an element of truth and the dangers identified should be guarded against, but there is much more to be said.
>
> For example, although engineers are important in systems work, economists, psychologists, biologists and representatives of several other disciplines have also played a large part both in developing theory and in practice. The system approach affords a way of integrating all relevant knowledge and technique in analyzing and formulating ways of handling a problem. It should also be noted that although physical and hardware problems have been central in the past, there have been many instances, particularly in the space program, where the emphasis has been on adapting technology to man rather than man to technology. In the final analysis, system approaches are simply powerful tools, which like all tools, can yield harm if badly used, but if used well can be a source of substantial good."[7]

Thus, the system approach to problem-solving and decision-making enhances human resources in that it:

- Emphasizes the adaptation of technology to man.
- Presents an integrated process and tool which can be utilized by man to analyze and resolve any problem.

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[7]U.S. Congress, Senate, Committee on Labor and Public Welfare. Ibid., p. 206 (Testimony of Carl F. Stover, Executive Director, National Institute of Public Affairs of Washington, D.C.).

In What Ways Has The System Approach Been Used Effectively to Solve Problems?

19 Educators must be made aware that the basic assumptions and methods of the system approach are being applied in the resolution complex and socioeconomic problems. Rowen has stated that:

> "...While their [methods] application has been limited by insufficient recognition of their utility and insufficient funds, they are important to the system development process of analysis, design, and implementation.
>
> The first step of this process, system analysis, is a framework that permits the judgment and experience of experts in numerous fields to be combined in order to yield results that transcend any single discipline.
>
> The process of system analysis basically implies a sequence of activities such as the following: (1) definition and detailed description of the boundaries of the system; (2) functional description of the system in terms of the component sub-systems and their operational interactions; (3) determination of objectives and criteria of optimal system performance; (4) examination of reasonable alternative configurations of system elements that approximate optimal system performance and the determination of the consequences of each configuration in terms of feasibility, acceptability, and cost-effectiveness; (5) finally, objective presentation of these alternatives and the supporting evidence to the responsible decision-makers so that they may make appropriate decisions with respect to selecting one of the alternatives for design and implementation, keeping in mind, of course, that a legitimate outcome may be to make no changes.
>
> Although this process is straightforward in concept it can be exceedingly complex and difficult in application.
>
> The complexity of application is commensurate with the complexity of the problem. Thus, the great socio-economic problems of our time are so complex and massive in scope that their analysis require more than the individual analyst. They require an integrated team approach."[8]

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[8]U.S. Congress, Senate, Committee on Labor and Public Welfare, Hearings on S. 2662, Utilization of Scientific Manpower, 89th Congress 1st and 2nd Session, 1966, p. 53-54 (Testimony of Thomas C. Rowen, President, Systems Development Corp. of Santa Monica, California).

21 Let us review our progress by summarizing the pertinent points already established.

- First, one must realize that the "system" concept is not new.
- Second, one must appreciate that the system approach utilizes the methods of science and logic.
- Third, one must be made aware that the science and technology of the system approach are being applied in the resolution of educational and socio-economic problems.
- Fourth, one must realize that the system approach is a powerful technology that can be used to enhance human resources.
- Fifth, one must understand that the system approach is an evolving science and technology and, as such, is subject to limitations and possible pitfalls.

22 In addition, let us review several generalizations which have been established:

- Everyone is aware of many examples of "system".
- The system approach tends to be methodological, explicit and objective.
- The system approach can be used as a logical and productive tool for problem-solving and decision-making.
- The system approach can be used to resolve problems in the behavioral sciences.
- The system approach can be used to facilitate the adaption of technology to man and the enhancement of human resources.

As a fundamental necessity for achieving an understanding of subsequent presentations, you need to know the following operational definitions:

1. What is performance?

23 "Performance (functional) is the carrying out of duties which must be executed in a specified manner."

2. What are performance conditions?

24 "Those states or modes that influence the qualitative and quantitative aspects of performance."

3. What are performance criteria?

25 "The standards or measures by which performance can be judged."

4. What are performance objectives?

26 "The stated, pre-determined goals of performance which can be expressed in measureable terms."

5. What are performance products?

27 "The anticipated and measureable end results or outcomes of performance."

6. What are performance requirements?

28 "The defined performance requisites relative to an anticipated or desired product."

As an OPERATION PEP participant, you need to know the answers to the following questions:

1. What is Meant by a System?

2. What is Meant by System Analysis?

3. What is Meant by System Synthesis?

4. What is Meant by the System Approach?

5. What Benefits Does the System Approach Offer Education?

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WHAT IS MEANT BY A SYSTEM?

29 A system is:

> "the gestalt which results from the sum total of separate parts working independently and in interaction to achieve previously specified objectives."

30 The idea of totality can be related to the structure, performance, requirements and products of the system. The totality of the effort generated and the resultant performance products produced by the sum total of the separate parts working independently and in interaction is greater than any one could predict by examining the separate parts in isolation.

31 A system can always be viewed or studied as a sub-system of a larger system. In the interest of clarity, the larger system is called the environment.

32 The environment includes:

> "all of the external and internal circumstances and conditions which effect an organism and/or system at any stage of its existence."

33 The environmental characteristics, situations and conditions will directly affect all aspects of system performance. The environment provides the inputs for system performance. In addition, the environment receives the products of the system as outputs.

34 The environment evaluates the performance effectiveness of system products and feeds back information to the system as inputs. This continuous process creates a "closed-loop" pattern of relationships between the system and its environment (see FIGURE 1).

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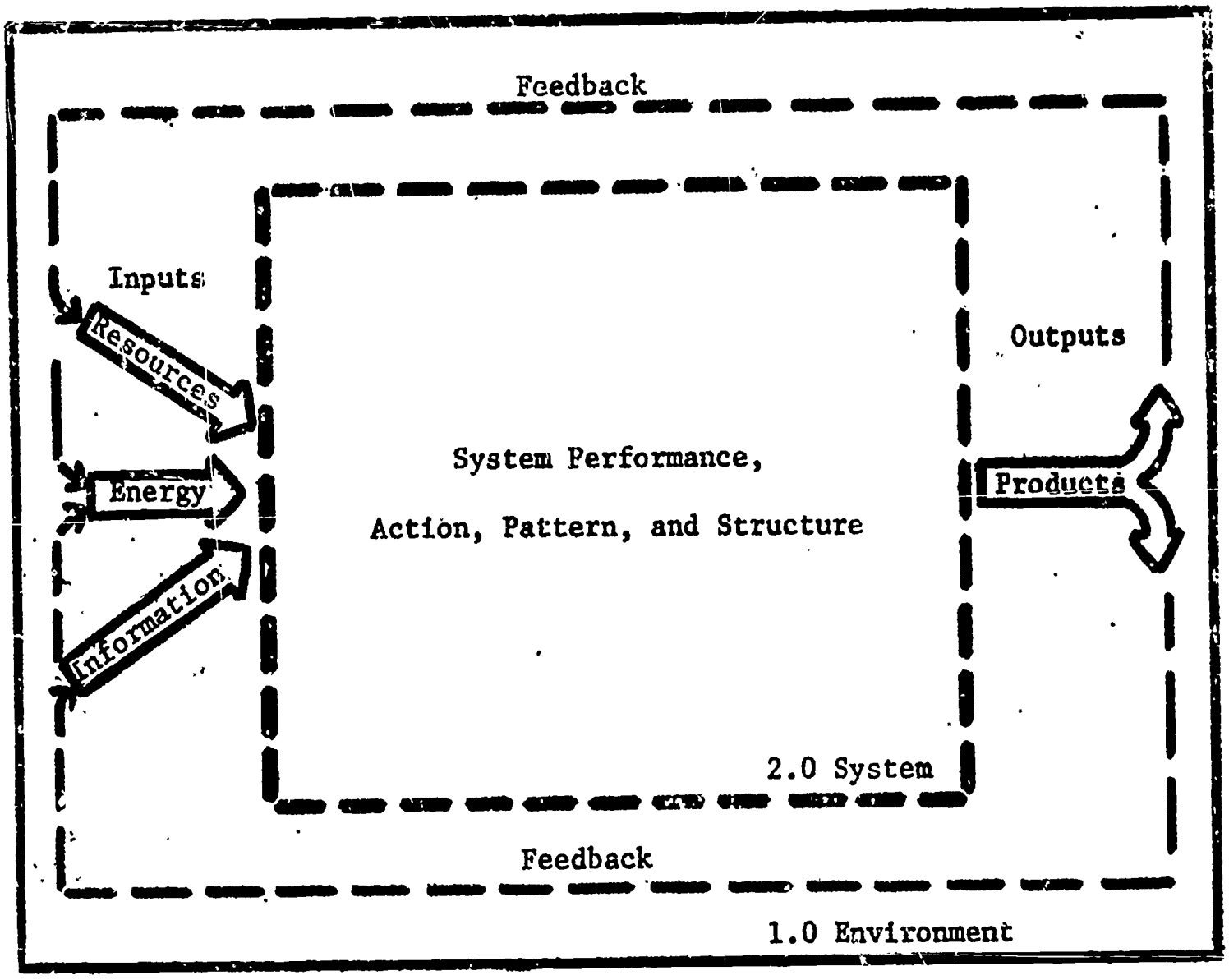
FIGURE 1



36 The model (FIGURE 1) reveals other relationships between the system and its environment. First, the environment must provide sufficient energy for the system to achieve its objectives in terms of the performance requirements. The energy capacities and capabilities for system performance are controlled by the environment through policy, and are reflected in the performance requirements. Thus, by controlling the energy, the environment regulates system performance and resource utilization.

37 Second, the environment must furnish the required human, physical and financial resources necessary for system functioning. These resources must be allocated and utilized by the system in the achievement of the system's specified objectives.

38 The system is a structured portion of its environment. The environment experiences continuous evolutionary growth and development. Therefore, the system must be flexible and adaptive to changes in the environment. These environmental changes will be reflected by changes in the system's characteristic actions, patterns and structures. These system changes can be studied when they are related to the changing performance requirements and the performance effectiveness of system products.

WHAT IS MEANT BY SYSTEM ANALYSIS?

39 System analysis is:

> "a generalized and logical process for identifying and breaking down, into as many carefully distinguishable parts as possible, the structure, parts and interactions of a system."

40 The process seeks to determine how these factors are related to each other within the characteristic actions, patterns and structures of the system. Thus, the primary purpose of analysis is to secure valid information.

41 The analysis process requires that one first identify and define the functions and tasks of the system and the environment. This implies that one can examine a total context, an environmental context and a system context. Thus, the environment can be analyzed separately from the system. Any context can be explained in terms of situations, conditions and characteristics. The following definitions are presented for clarification:

42 Context - An identifiable and definable unit consisting of a set of related and interacting factors and events which exist within the boundaries and dimensions of the unit.

43 Situations - The domains of circumstances in which the context is located.

44 Conditions - The states or modes in which the context exists or which gave rise to the context.

45 Characteristics - The descriptive, qualifiable, and quantifiable features of a context which can be used to describe its nature.

46 The application of the analysis process to a given context will produce the necessary information which is required to understand the characteristic actions, patterns and structures of the context.

WHAT IS MEANT BY SYSTEM SYNTHESIS?

47 System synthesis is:

> "a highly specific and logical process for combining separate elements into a desired orderly system after first identifying and determining the required actions, patterns and structures necessary for system performance."

48 The process seeks to create alternative solution methods and strategies which are based upon the valid information gained through system analysis.

49 The alternative solution methods and strategies can, in turn, be analyzed in terms of specified system criteria. Thus, the validation of the synthesis product is performed using a proof by analysis. The ultimate proof of the synthesis product resides in the evaluation of its performance effectiveness.

50 The synthesis process requires that one first identify and define the boundaries and dimensions of the specified performance requirements. These performance requirements must be negotiated into performance specifications in terms of system performance capabilities and environmental performance expectations. The performance specifications, in turn, must be translated into system performance objectives in full light of environmental expectations relative to the expected system performance products.

51 The application of the synthesis process to a given context will produce a quality system performance product. The product will be designed to fulfill system performance requirements and, in turn, will satisfy environmental expectations relative to performance effectiveness.

WHAT IS MEANT BY THE SYSTEM APPROACH?

52 A system approach is:

> "a 'closed-loop' analytic and developmental process which can be utilized to continuously: (1) assess the results of performance; (2) maintain sensitivity to performance requirements; and (3) provide for the self-correction of performance in order that the specified objectives can be achieved."

53 This approach presents a method for the common sense qualification and quantification of problems and the solutions to problems. This is possible because performance requirements, objectives, conditions, criteria and products are all defined using consistent and compatible units or measures. Performance always has two terminal referents: first, the defined requirements; and second, the specified products. The objectives, conditions and criteria for performance are always expressed in terms which are compatible with the characteristics of the requirements and the products.

54 The system approach requires application of rigorous logical analysis and synthesis methods and other scientific procedures. Thus, the approach requires a commitment of acceptance regarding the use of these scientific methods and procedures before its potential benefits can be achieved.

WHAT BENEFITS DOES THE SYSTEM APPROACH OFFER EDUCATION?

55 The successful performance of the management function depends upon a thorough understanding of problem-solving and decision-making.

56 Managers need to develop skills and learn new techniques that will assist them in adjudging and capitalizing on technology so it works with, and not against, their efforts to resolve problems.

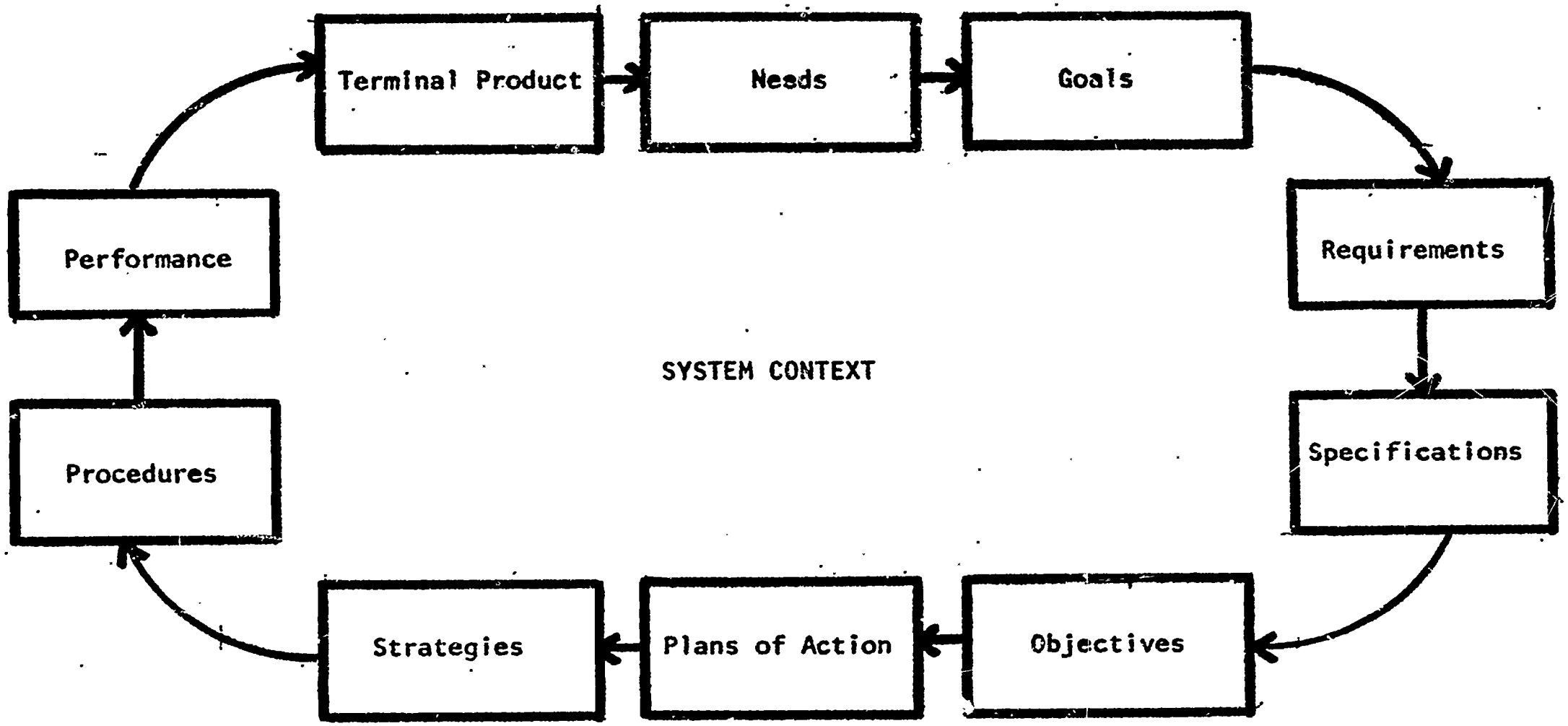
57 Management functions can be related to the system-environmental pattern of relationships.

58 Management problems and decision-making requirements can then be related in a generic pattern of systematic performance.

59 The system approach can, therefore, be used as a generic management tool and can be applied to any function of management.

60 The pattern of system performance can be displayed as a generic management model, as follows.

A GENERIC MANAGEMENT MODEL



A MODEL OF A SYSTEM APPROACH--A LOGICAL TOOL FOR PROBLEM-SOLVING

62 A problem-solving model can be used as a guide for the analysis of any change and/or problem situation without disturbing the existing system. The utilizer can simulate problem solution alternatives by varying the conditions and characteristics of the problem and its change context. Thus, the system approach to problem-solving is an analytical process facilitating the collection and utilization of pertinent data in decision-making activities.

63 The model outlines an analysis and synthesis process which is both flexible and adaptable. Consider the model and its process:

- The process presents a control model.
- The model promotes objectivity and elimination of information biases.
- The model provides a logic structure for validating decision alternatives.
- The model is generic and offers heuristic benefits in that:

  --one can apply it to any problem

  --one can use it to extend his problem-solving capability

  --one can use it in support of decision-making

  --one can see the entire process (gestalt) with its interrelating conditions and alternatives.

A MODEL OF A SYSTEM APPROACH TO PROBLEM SOLVING

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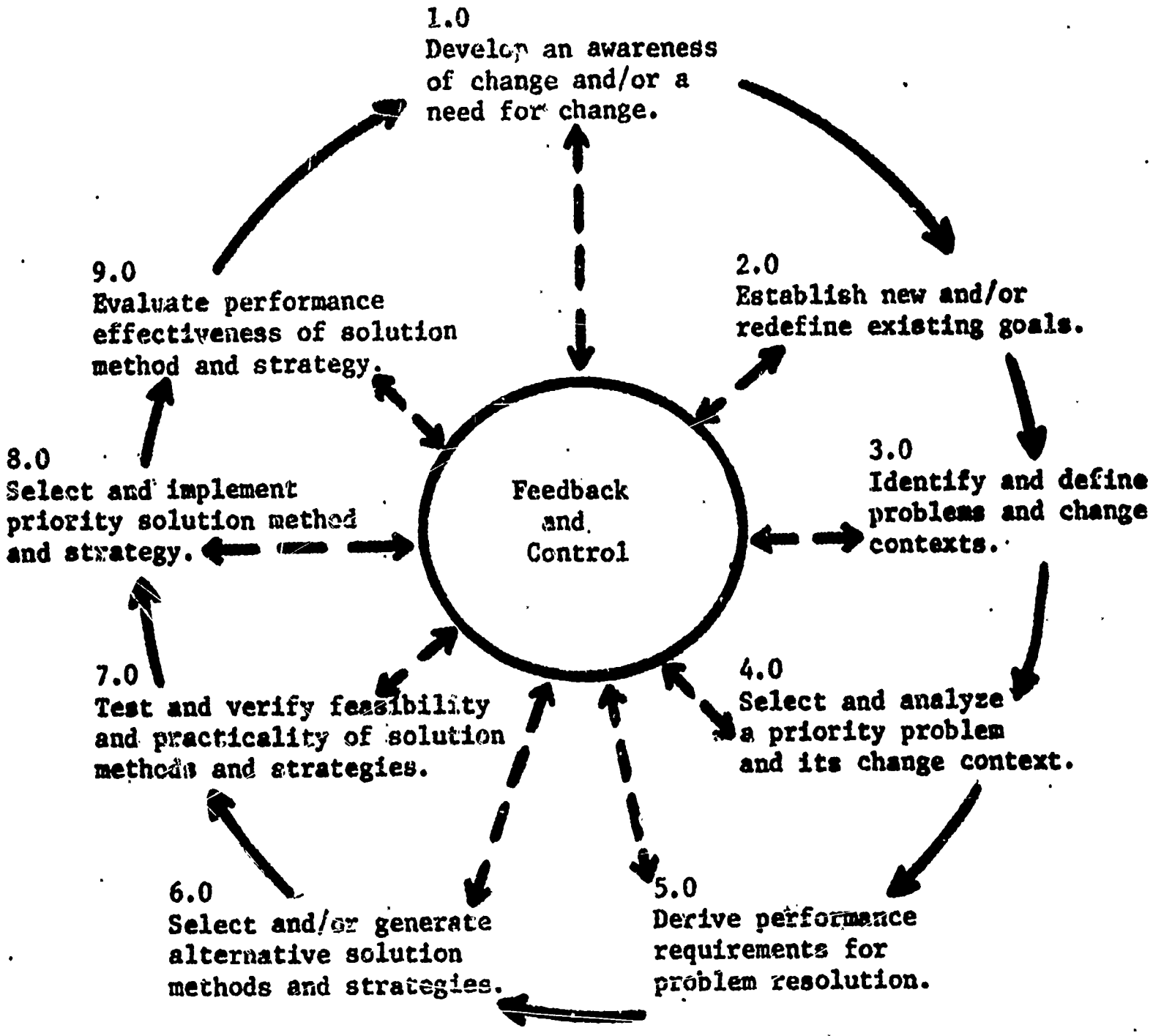

65 An examination of the model reveals that:

- the model is a "closed-loop" logic system.
- evaluation data "feeds-back" to every step to facilitate continuous revision and analysis of products.
- an iteration loop exists between each component of the system and every other component facilitating "check-back", feed-back, and verification procedures.

66 A system approach can be used to solve any simple or complex problem existing at any level of system structure and/or function. A biologist studies living cells as units (systems) of structure and function. He may also apply the system approach to problems arising in the digestive, endocrine, or nervous systems. Further, he might study the interaction of these units as subsystems of a larger system; namely, the living body. Finally a living organism can be studied as a component of a larger system called the environment.

67 A system approach to problem-solving can be utilized through system analysis, design and implementation. Its major contributions are realized when it is used as a functional approach to problem-solving. Consider a simple model of a system and its environment.

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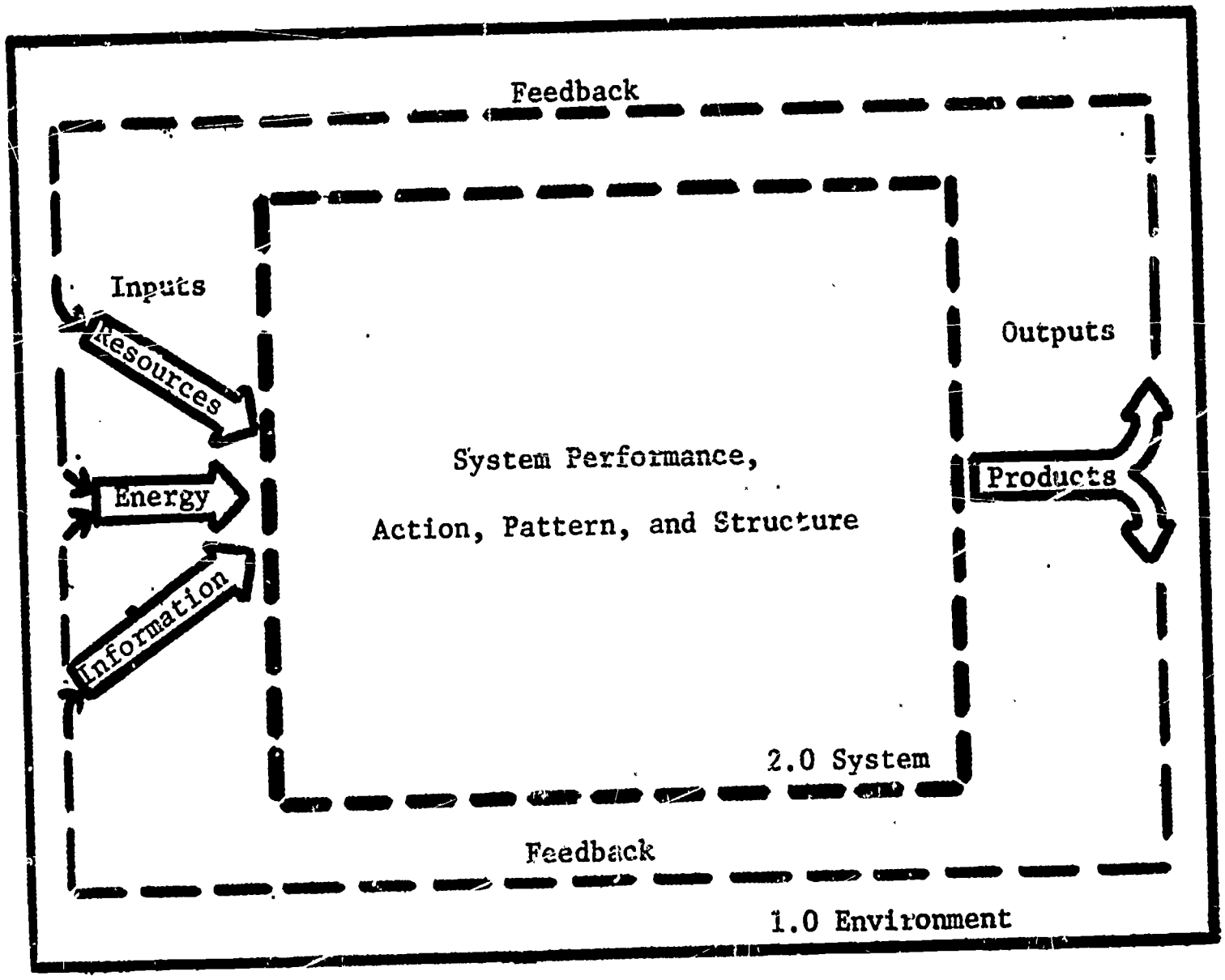

69 Geyer has pointed out that:

> "...we need to know the boundaries, the interfaces, the inputs to a system and the outputs from it. It is necessary also to understand (1) the system from which the inputs arrive, (2) the interrelationships within the system itself, and (3) the effects on the system which receives the outputs."[9]

70 Thus, the system and its environment engage in dynamic interaction which produces many changes and problems. A system approach to problem-solving can be regarded as:

- A logic system which can be applied in the solution of problems arising in a system and/or its environment.
- An effective approach for determining valid solutions to problems in that its methods and procedures can be applied to both the problem and the change contexts.

71 The benefits to be derived through use of a system approach to problem-solving are greatest when the process is utilized as a functional approach to problem solving. This means that the process must be used while the system is in its dynamic state--as it is operationally functioning.

72 The pertinent question is, "What would one be required to do in order to apply a system approach to problem-solving in an educational system?" Let us consider what an educational system might do:

- The scope of inquiry would be the whole educational process and its environment.
- The object of inquiry would be the educational system including the school and all its functions--not just a part or component of the system.

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[9]U.S. Congress, Senate, Committee on Labor and Public Welfare, Ibid., p. 174 (Testimony of John C. Geyer, Professor, Johns Hopkins University, Baltimore, Maryland.)

- The primary purpose of inquiry and analysis would be to determine the performance requirements of the system.

- For ease of inquiry and analysis, the system would be divided into interrelated and interacting sub-systems to which are assigned specific performance functions.

- For each of these sub-systems performance specifications, objectives, conditions and criteria would be developed.

- A system approach would be implemented to analyze all aspects of system and sub-system performance and each evolving problem and change context.

- A variety of alternative problem solution methods and strategies would be generated to increase the range of decision-making and improve the quality of each alternative.

- Decisions would be evaluated against established performance requirements, specifications, objectives, conditions and criteria.

- Each decision would be analyzed to foresee and reduce future possible adverse consequences and to increase the probability of success.

- The effects of a decision would be controlled through management action to prevent possible adverse consequences and the effect would be monitored for informational benefits and other clues which could be fed back to system management.

- The effectiveness of performance would be continuously analyzed and evaluated to determine system change requirements and success.

73 A system which stimulates the development and use of better inquiry and problem analysis techniques and then applies the results of these techniques to decision-making will demonstrate superior management capabilities.

74 In summary, a system approach to problem-solving takes into account:

- All aspects of a problem including its characteristics, conditions and situations.

- The interrelationships existing between the elements of the problem.

- The analysis of information pertinent to the problem.
- The relevant actions, patterns and structures influencing the problem.
- The structuring of alternative solution methods for resolving the problem.
- The selection of the most feasible solution method alternative.
- The implementation of the selected solution method.
- The testing and revision (if necessary) of the implemented solution method.
- An assessment of the effectiveness of the solution method.

75 Let us review a summary of the pertinent points presented in this section:

- A model of a system approach to problem-solving is a "closed-loop" logic system that can be used as a powerful decision-making tool.
- A system approach to problem-solving includes analysis, synthesis, evaluation, revision, iteration, verification and information handling procedures.
- Both the model and the approach presented can be used to simulate problem resolution alternatives without disturbing the existing educational system.
- The most important benefit to be gained through application of the model and the approach to a problem and/or change context is the collection and utilization of pertinent data for decision-making in terms of practical and feasible performance.
- Both the model and the approach are adaptive in terms of problem complexity, existing functional and structural states, levels of organization to which it is applied and relevant system-environment relationships.
- The system approach to problem-solving presents both a method and a means for attaining superior management capabilities.

A RATIONALE AND FRAMEWORK FOR IMPLEMENTING A SYSTEM APPROACH TO PROBLEM-SOLVING WITHIN THE EDUCATIONAL SYSTEM

76 An educational system can be said to consist of formally differentiated agencies to which are delegated the social function of training the learners for societal roles which can be expressed in terms of measurable skills, knowledges, etc. In the words of H. Thomas James:

> "The whole system develops out of societal demands for services. The system stays healthy as long as it is responsive to those demands. It withers when it fails to be responsive to these demands, and other institutions grow to perform the functions. We have many sub-systems that have grown to replace the functions once performed or intended to be performed by the public schools."[10]

77 The educational system is organized into sub-system levels in order to plan and manage educational endeavors. The levels are integrated in support of the educational function. James has reported that:

> "...school boards continue to be an essential link in our institutional arrangements for public education. The fundamental power and authority for public education derives from the constitutional mandate to the legislature to establish a system of education and flows from the legislature to the State Board, to the county boards, to local boards of education."[11]

78 The above-stated quotations suggest three implications for system analysis, problem-solving and decision-making activities:

- The educational system was developed to perform functions.

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[10] H. Thomas James, "Conclusions and Summary of the Conference," Patterns for the Administration of Curriculum Development and Instructional Improvement (Sacramento: California State Department of Education, 1965), p. 66.

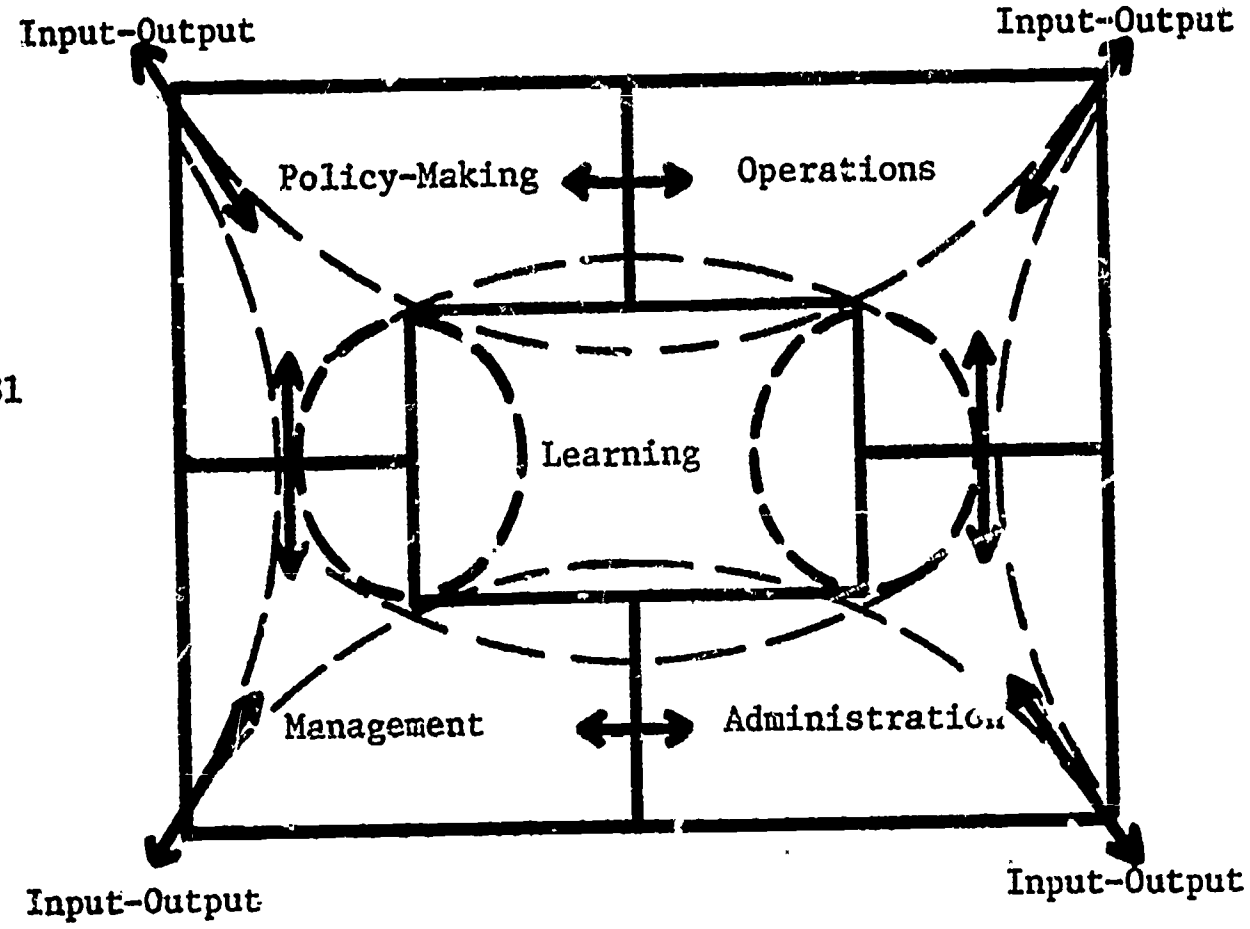
[11] Ibid., p. 69.

- The educational system is organized into sub-systems--one of which is policy-making.
- The educational system is a function of the society which it serves.

79 In keeping with the stated organizational implication, the California educational system may be viewed as consisting of several sub-systems:

Policy-making (Sub-system)	California State Legislature California State Board of Education County Boards of Education Local School District Boards of Education
Management (Sub-system)	California State Superintendent of Public Instruction California County Superintendents of Schools District Superintendents of Schools
Administration (Sub-system)	California State Department of Education Offices of County Superintendents of Schools Local Educational Agencies
Operation (Sub-system)	Instructional Services Business and Auxiliary Services Pupil Personnel Services Special Services Administrative Services Financial and Legal Services Support Services

80 The primary benefit to be derived through use of a system approach to educational problem-solving is the efficient management of performance in order that the system can effectively achieve its objectives. Since most performance within the educational system is directly related to the learning process, an examination of this system must relate to the learning function. Consider a model of the educational system which features system components and system interaction relative to learning.

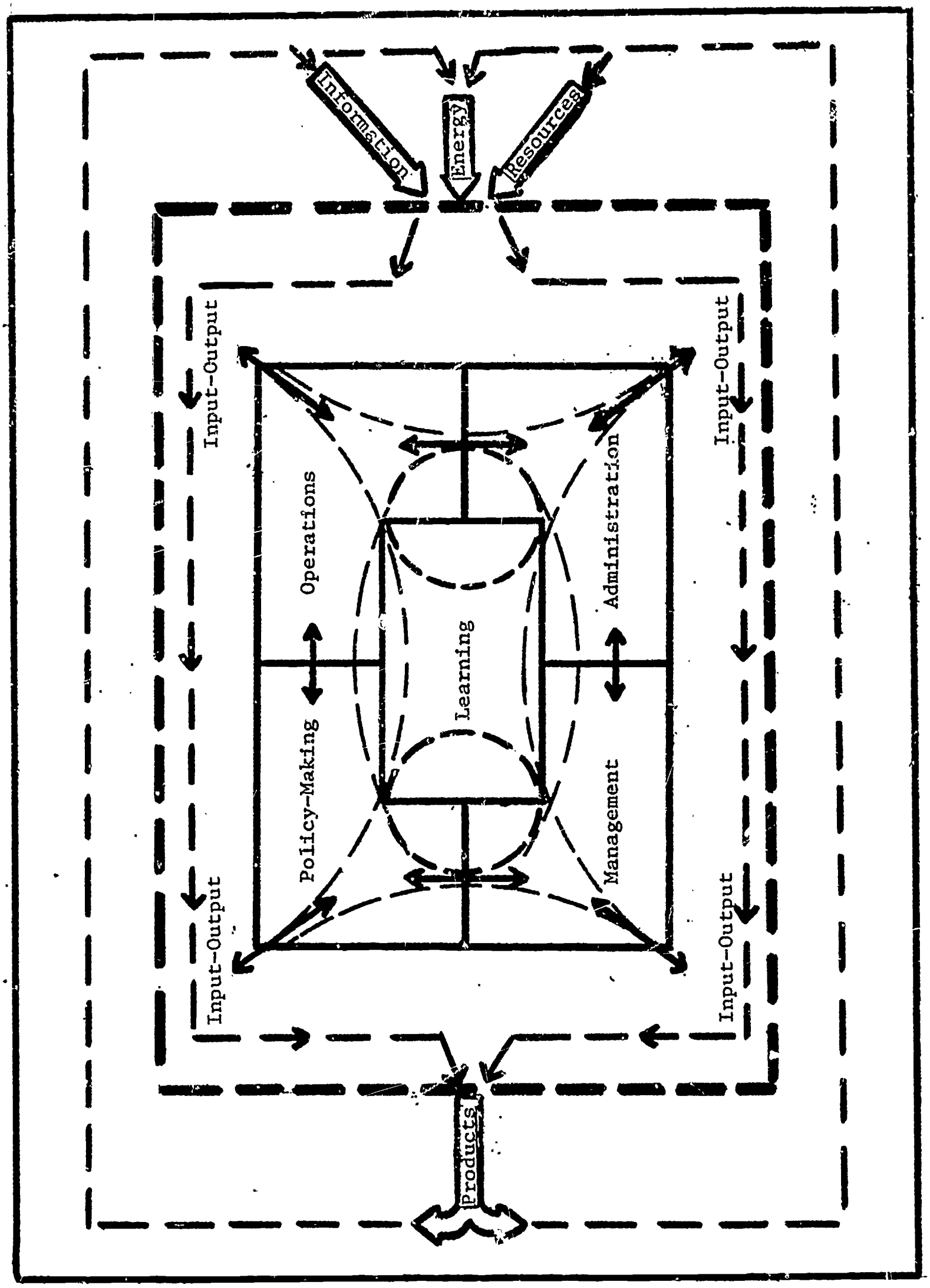


81

82 An educational system must focus upon the learner and upon every dimension of probability relating to the fullest development of his desired potentialities. The goal of the system is the successful social integration of the learner and the society of which he is a part. The learning process features direct interaction between and among four critical components: (1) the student, (2) the teacher, (3) the curriculum and (4) the relevant methods/means media. Education must, therefore, be regarded as a dynamic integration process which focuses upon the developmental and life needs of a learner-product. Thus, a system approach to problem-solving and decision-making must take into account the system and all its components in the dynamic performance state.

83 A modular pattern of relationships and interactions relative to system performance integration can be constructed by connecting the arrowheads, in the foregoing model, with dotted lines. This pattern

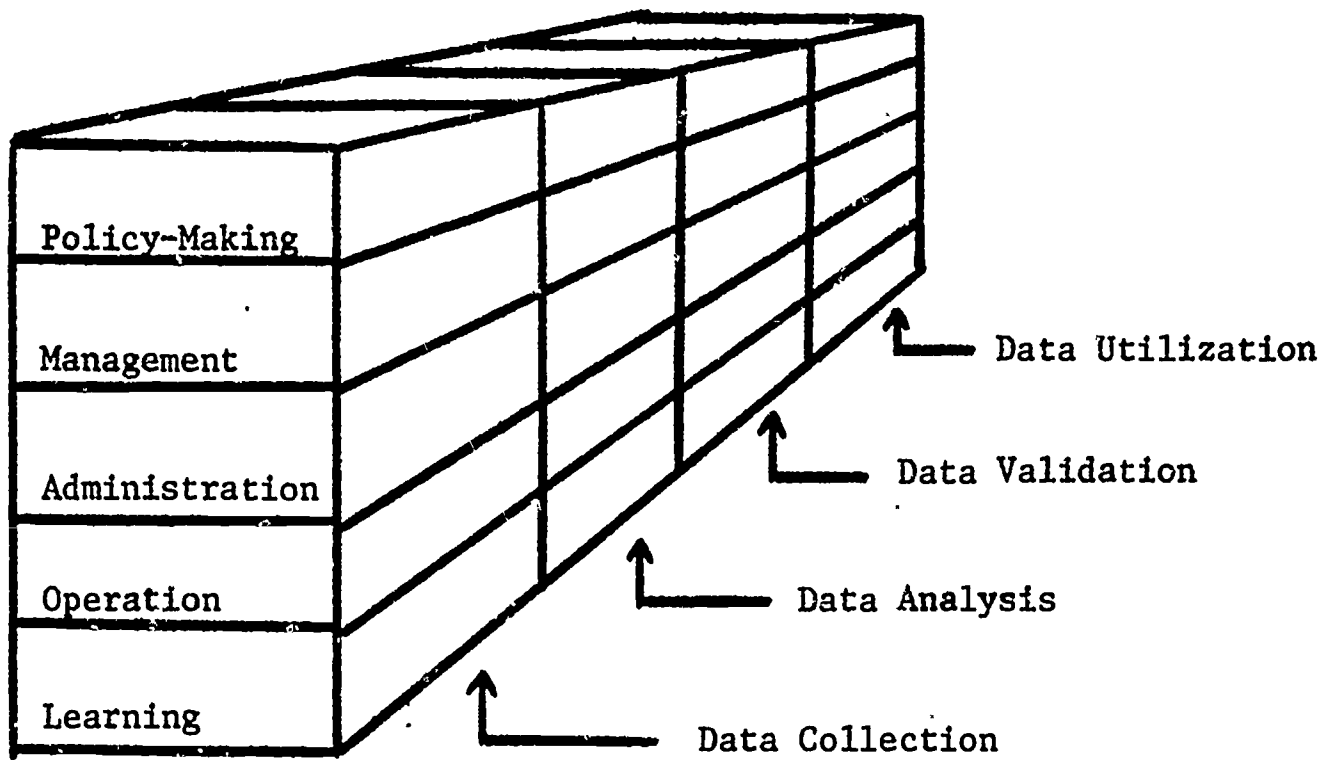
can be substituted for system performance in the model of system-environment relationships.



85 The model can be used to explain many relationships which have been traditionally recognized in educational systems. The model reveals that system performance integration can be related to four functional levels of organization; namely, policy-making, management, administration and operation. Each of these levels can be related directly to the learning function of education.

86 In addition, a system approach to problem-solving and decision-making can be applied to problems evolving at any level of organization and/or complexity within a system.

87



88 The system approach should not be applied at any level of organization and/or complexity other than those required in order to resolve the problem effectively.

89 The functional performance requirements of an educational system suggest another strategy for its organization; i.e., performance levels and areas of instructional service. A functional analysis of the policy-making, management, administration and operation

sub-systems could be compared to the results of a functional analysis performed in the areas of instructional service. An integration and/or a match-mis-match comparison of the results of these two separate analyses would provide critical information for inquiry, problem analysis and decision-making. Thereby, all performance could be directly related to identified functions in the areas of instructional service.

90 The ultimate benefits of such analyses and comparisons by functions would include:

- Analysis of performance vs. analysis of cost.
- Evaluation of performance effectiveness vs. costs.
- Analysis of instruction benefits vs. analysis of system requirements.
- Analysis of what performance is required vs. analysis of what performance is being demonstrated.

91 A functional analysis framework for an educational system is presented on the next page. The application of a system approach to problem-solving within such a framework would assure a functional approach to planning and management. The primary focus, upon adoption of a functional approach, would be upon educational functions and performance effectiveness.

92 A plan of functional organization could be developed which would facilitate:

- The delineation and definition of functions to be performed.
- The allocation of financial, physical and human resources, capabilities and capacities to perform defined functions.
- The assignment of responsibilities for functions to be performed.

A FUNCTIONAL ANALYSIS FRAMEWORK FOR AN EDUCATIONAL SYSTEM

FUNCTIONAL ANALYSIS BY AREAS OF INSTRUCTIONAL SERVICE								FUNCTIONAL ANALYSIS BY LEVELS OF SYSTEM ORGANIZATION		
Pre-Formal		Elementary		Secondary			Special			
Pre-school and Nursery	Kindergarten and Pre-first	Primary Grades	Inter-mediate Grades	Junior High	Senior High	Adult and Con-tinuation	Education Programs	Policy-Making Sub-system	Manage-ment Sub-system	Operation Sub-system
									Admins-tration Sub-system	

- The delegation of commensurate authority to perform assigned functions.

- The establishment of accountability for performance of functions.

- The evaluation of performance effectiveness by functions being performed, in terms of cost effectiveness criteria.

- The assessment and revision of the plan of functional organization.

94 The following criteria should be carefully evaluated in the selection and/or the changing of functions detailed in the plan:

- The functions are required and/or permitted by law.

- They are directed toward goals commonly held by the citizens and schools of the region.

- Need for them is indicated by the changing character of educational problems and concerns.

- They are desired and will be performed by school districts.

- They take precedence over other possible functions which might be performed using available resources.

- They can be performed more effectively by the educational system than any other public agency.

- They can be performed in sufficient quality and quantity to meet the identified and defined priority need.[12]

95 Consider the requirements which must be met in implementing a system approach to problem-solving. A recently publicized study of major defense systems (Project Hindsight) revealed the problems encountered in the use of new technology. The project report shows:

> "...conclusively that the application of new technical ideas requires that three major criteria be satisfied:

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[12]Adapted from: Development and Change in the Office of the Los Angeles County Superintendent of Schools. (Los Angeles: Office of the Los Angeles County Superintendent of Schools, 1966), p. 20-21

1. There must be a well-defined problem.

2. There must be an organized group of scientists and engineers capable of working on the problem.

3. Sufficient resources must be committed."[13]

96 This quotation and other articles suggest that there are three requisite conditions for the successful application of a system approach to problem-solving in any dynamic organization. These conditions are:

- That it be used by decision-makers.
- That it be fed with ideas from a broad informational baseline which accurately represents the system in its dynamic organizational, environmental and performance states.
- That it be conducted by a task force consisting of competent and representative staff members working with skilled consultants, who possess multi-interdisciplinary talents.

97 In addition, each decision-maker needs three problem-solving aids:

- A conceptual scheme to guide his actions.
- An orderly and systematic process for problem analysis and decision-making.
- Criteria for evaluation of success.

98 Consider also that the primary strengths of the system approach to problem-solving and decision-making stem from the methods of science which enable the process to be:

- Replicated--others can use the process to achieve similar results.
- Made explicit--the process and results are clearly visible.

U.S. Congress, Senate, Committee on Labor and Public Welfare, Ibid., p. 156. (Testimony of Paul Grogan, Director, Office of State Technical Services, U.S. Department of Commerce).

- Verified--the process and results can be confirmed or substantiated.
- Self-correcting--the process provides for continuous revision through iteration.
- Logical--the process and results are in accordance with inferences reasonably drawn from events, conditions, situations, or circumstances.
- Objective--the uncertainties and subjectivity have been reduced during the process.
- Quantifiable--numbers and number relations can be applied to the process and results.
- Empirical--the process and results can be verified through experience, experimentation, observation, etc.
- Effective--the process produces results that are decisive.

99 The reader has had an opportunity to review:

- An introduction to a system approach.
- An explanation of what this approach entails.
- An overview of the benefits it offers.

100 A system approach for solving educational problems offers many advantages to decision-makers. Its application will enhance the human resources of this nation by enabling planners and managers to resolve difficult and complex educational problems.

101 As a final note, one must remember that the system approach requires application of rigorous logical analysis and synthesis methods and other scientific procedures. Thus, the approach requires a committment of acceptance regarding the study and use of these methods and procedures before its potential benefits can be achieved. In addition, it must be realized that the most serious limitation of the approach resides in the person who uses it as a tool. Many skills and knowledges must be gained before significant levels of confidence

can be developed. The quality of reward achieved depends upon the expertise developed by the user. Expertise is gained through knowledge and experience--we "learn by doing".

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